

## MIT Wants to Make Computing as Easy as Breathing; [FINAL Edition]

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**Full Text** (929 words)

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Anant Agarwal led me from his bright corner office at the Massachusetts Institute of Technology down a hall to his glass-walled research lab, warning that I would laugh when I saw the latest "handheld" computer built to test his futuristic microprocessor.

I howled at the geeky contraption, which seemed so big and awkward that only the Jolly Green Giant would consider it a handheld. But Agarwal, an MIT professor and researcher, explained that the prototype wasn't about size or shape.

It was about the invisible wiring on its silicon chip, designed so it can be reprogrammed to allow one device to perform many tasks, allowing a cell phone to morph suddenly into a TV or scanner. Today's computer chips, by contrast, are pre-wired with fixed sets of instructions.

Agarwal wants to redesign chip software and hardware for the mobile age, creating chips that can power chameleon devices. If devices were chameleon-like, he reasons that people could get more done with less gear, theoretically making computing more mobile. Also, devices embedded in "intelligent" rooms and stationary objects could accomplish more simply by retrieving new instruction sets.

"Call it a universal logic chip that can do anything," Agarwal said.

His reprogrammable chip -- called RAW for "raw architecture workstation" -- is one of many key pieces in MIT's \$50 million Project Oxygen, which has involved more than 150 researchers and is in its fifth year. The lofty goal of the project, funded partly by the Defense Advanced Research Projects Agency, is to create a new computing environment, in which computer firepower would be ubiquitous and manipulating computers as easy for people as breathing.

Oxygen researchers want people to throw away the mouse and talk to their computers, some of which would be embedded in walls and ceilings. Oxygen was one of many efforts exploring pervasive computing launched by large universities and technology corporations during the dot-com boom.

In 2000, Project Oxygen began the "technology transfer" process of giving prototypes to its six corporate sponsors and exploring the creation of companies to sell the technology. The MIT team also is working on two possible operating systems to combine the many pieces of the Oxygen puzzle; one is called O2s and the other MetaGlue.

"In the first two or three years, it was like letting a thousand flowers bloom," said Victor Zue, director of MIT's Laboratory of Computer Science and a leader of the project. "Everybody was doing their own thing. Then about a year ago, we started developing the operating system, which needs a lot of properties, including the ability to be rapidly configurable."

One ambitious premise of Oxygen is integrating many cutting-edge technologies into a single, behind-the-scenes system to let people move around freely while still retaining access to computing resources, such as printers and databases. Accomplishing that means speech-

recognition software has to work with visual-recognition software as well as sensor networks that track people's movements.

MIT's attempts to develop such a complex computing environment have led to unusual experiments, including creation of a cluster of 1,020 microphones powered by the RAW chip. Agarwal showed off the microphone bank on my recent visit, explaining that it uses special software to correlate sounds picked up by the microphones with video footage shot in the same room. The idea is to help microphones identify and track a single speaker through a crowded, noisy room.

"We just made it into the Guinness Book of World Records as the world's largest acoustic microphone array," he said.

Other components of Oxygen include software for processing language at a deeper level than ordinary speech recognition, to help computers decipher meaning. There is also an indoor sensor network for tracking people and things called Cricket, which relies on the simultaneous transmission of radio and ultrasound signals.

Along with Nokia and Philips Electronics, one big Oxygen sponsor has been Hewlett-Packard. Already, Oxygen research has helped shape handheld computing and virtual meeting technologies emerging at HP.

Fred Kitson, director of HP's Mobile & Media Systems Lab, said Oxygen's early work influenced a virtual studio collaboration system that HP is developing for Dreamworks. The software will let Dreamworks moviemakers in three cities collaborate online in a simulated studio, but it also has potential in other industries.

"We have business aspirations around it, and we have an organization around it to bring it to market," he said.

Kitson said HP experimented with MIT's Cricket system for pinpointing the whereabouts of people indoors but ultimately rejected it in favor of other sensor technologies. He was skeptical of the reprogrammable chip concept, acknowledging there is widespread disagreement in the industry about the strategic value of the approach.

"Part of what we expect Oxygen to do is push the boundary and show what's possible," Kitson added. Later, "we will worry about the pragmatic implications."

Agarwal would be among the first to agree that MIT researchers push boundaries, and he thinks they have still barely scratched the surface of what such ideas will soon make possible.

The changes he foresaw eight years ago when he started thinking about reprogrammable chips are now materializing, he said, and they're big.

"By 2007 or 2010, we are going to have an ungodly amount of logic on a chip," Agarwal said. That's roughly 1,000 times the computing power a chip had in 1990.

"What that means is computing becomes essentially free," he said. "We can pretty much do whatever we want to do on a single chip of silicon."

As to what that ultimately will mean, he shrugged: "The true impact is unfathomable."

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